Rad-57c™, Rad-57m™, Rad-57cm™
Signal Extraction Pulse CO-Oximeter™

Service Manual

Rad-57c™, Rad-57m™, Rad-57cm™
Signal Extraction Pulse CO-Oximeter™

Service Manual

This Rad-57™ Service Manual is intended to provide the necessary information for proper servicing of the Rad-57 family of Pulse CO-Oximeters. This manual is structured to support troubleshooting to the assembly or module level. This manual does not provide instructions for troubleshooting to the printed circuit board component level. Do not service a Rad-57 unit without completely reading and understanding these instructions. Masimo service training is required prior to utilization of this manual.

CAUTION:

(U.S.) Federal law restricts this device to sale by or on the order of a physician

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Made in USA.

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Other patents pending

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1. Overview

1.1. About this Manual

This manual explains how to service the Rad-57 family of Pulse CO-Oximeters. Important safety information relating to the general use of the Rad-57 appears in the Operator's Manual. Other important safety information is located throughout this manual where appropriate.

1.2. **WARNINGS, Cautions and** Notes

Please read and follow any warnings, cautions and notes presented throughout this manual. An explanation of these labels is as follows:

A **WARNING** is provided when actions may result in a serious outcome (i.e., injury, serious adverse affect and death) to the patient or user. Look for text in a gray shaded box.

Sample of a **WARNING:**

WARNING: THIS IS A SAMPLE OF A WARNING STATEMENT.

A **Caution** is given when any special care is to be exercised by the patient or user to avoid injury to the patient, damage to this device or damage to other property.

Sample of a **Caution:**

Caution: This is a sample of a Caution statement.

A Note is provided when extra general information is applicable.

Sample of a Note:

Note: This is a sample of a Note statement.

2. Testing and Maintenance

2.1. Introduction

2.1.1. This chapter covers; Cleaning, Battery Operation and Replacement, Testing and how to obtain service under normal operation.

Note: No internal adjustments or recalibration is required.

2.1.2. Service should be done by qualified personnel only. Safety checks should be performed in accordance with local and governmental regulations.

2.2. Cleaning

WARNING: BEFORE CLEANING THE PULSE CO-OXIMETER, TURN THE UNIT OFF.

2.2.1. To clean the display panel, use a cotton swab moistened with 70% isopropyl alcohol and gently wipe the panel.

2.2.2. To clean the outer surface of the instrument, use a soft cloth moistened with a 70% isopropyl alcohol.

WARNING: DO NOT ALLOW LIQUIDS TO ENTER THE INTERIOR OF THE INSTRUMENT.

2.2.3. To decontaminate unit, refer to Section 4.2.2.

Cautions:

- **Do not autoclave, pressure sterilize, or gas sterilize this oximeter.**
- **Do not soak or immerse the monitor in any liquid.**
- **Use the cleaning solution sparingly. Allow unit to air dry. Excessive solution can flow into the monitor and cause damage to internal components.**
- **Do not touch, press, or rub the display panels with abrasive cleaning compounds, instruments, brushes, rough-surface materials, or bring them into contact with anything that could scratch the panel.**
- **Do not use petroleum-based or acetone solutions, or other harsh solvents, to clean the oximeter. These substances attack the device's materials and device failure can result.**

2.3. Battery Operation

2.3.1. The Rad-57 includes (4) AA alkaline batteries.

2.3.2. Before using the Rad-57 as a handheld or transport monitor, it is best to verify the charge level of the batteries. Please reference the Operator's Manual for specifications of battery life.

2.3.3. The battery charge LED indicators on the keypad will indicate the approximate life left with the batteries.

2.3.4. As a precaution, it is advisable to replace the batteries as soon as the final indicator starts flashing.

2.4. Replacing the Batteries

2.4.1. Turn the unit off and disconnect the patient cable.

2.4.2. Position the unit face down (use a soft surface to protect the unit from possible cosmetic damage).

2.4.3. Depress the battery cover release button and slide the cover off.

Caution: Do not use rechargeable batteries.

2.4.4. Remove all (4) batteries. Replace with (4) new batteries (Alkaline AA) paying attention to proper polarity positioning.

2.4.5. Depress the battery cover release button and slide the cover back onto the unit. Verify the button pops up securing the cover.

2.4.6. As soon as the batteries are installed the unit may turn on automatically. If not, turn the unit on and verify all LEDs illuminate momentarily. After the unit boots, the four charge level LEDs should remain lit and the message "No CbL" is displayed.

Note: Follow local governing guidelines for proper disposal of batteries. Do not incinerate.

2.5. Testing

2.5.1. To test the performance of the Rad-57 Pulse CO-Oximeter after repairs or during routine maintenance, follow the procedure outlined in this section starting at step 2.6. If the oximeter fails any of the tests, discontinue its use and correct the problem before returning the unit back to the user.

Note: Before testing, verify the batteries are fully charged. Disconnect any patient cables or sensors.

2.6. Power-On Self Test

2.6.1. While the unit is off, depress the Power/Standby button and verify the unit turns on, that all LED indicators illuminate momentarily and the speaker makes a beep sound. Depress and hold (~ 2 sec) the power button again and verify the unit turns off.

2.7. Key Press Button Test

2.7.1. With the unit on, press each soft key button (with the exception of the Power/Standby button), and verify that the oximeter acknowledges each key-press with an audible beep tone and/or by indicating an associated change on the display.

2.8. Menu Navigation Test

2.8.1. With the unit turned on, press the MODE-ENTER button several times slowly and verify the menu scrolls through the various top level menu selections:

2.8.1.1. Level 1: “no CbL” Connection verification.

2.8.1.2. Level 2: “AL VOL” Alarm volume.

2.8.1.3. Level 3: “90/LO” Alarm limit settings.

2.8.1.4. Level 4 ”SEn nor” Sensor sensitivity setting.

2.8.1.5. Level 5: “Trn OFF” Trend on or off setting.

2.8.1.6. Level 6: “888 / 888” Brightness setting

2.8.1.7. Press the button a sixth time. Menu should return to the beginning view.

Caution: The limits for SpCO and SpMet will remain set (“Sticky”) even during a power cycle. SpO2 limits will reset to the factory default after a power cycle.

2.8.2. Press the MODE-ENTER button once (should be at the “AL VOL” selection). Verify that pressing the up and down arrows changes the volume.

2.9. LCD Brightness Test

2.9.1. With the unit turned on, depress the MODE-ENTER button five (5) times. When the display appears as 888/888, use the up and down arrows to verify the brightness both lightens and darkens.

2.10. Functional Testing

2.10.1. With unit fully turned on and no cable or sensor plugged in, verify a message appears showing “no / CbL”.

2.10.2. If plugging in a direct connect sensor (not attached to a patient), verify a message appears showing “SEN / OFF”.

2.10.3. If plugging in a Red LNCS or Red LNOP cable (no sensor attached) verify a message appears showing “No Sen”.

2.10.4. If plugging in a RC cable (no sensor attached) verify a message appears showing “no / Cbl”.

2.10.5. When a sensor is attached to any of the cables, but not attached to a patient, verify a message appears showing “SEN / OFF”.

2.10.6. Attach the sensor to your finger. Verify a SpO2 and BPM signal is acquired within approx 10 seconds.

2.10.7. Press the Display button (or SpCO or SpCO/SpMet or SpMet button) and verify a Rainbow signal is acquired within approx. 30 seconds.

2.11. Testing with Masimo Rainbow Tester (New Rad-57 only)

2.11.1. Please Note: The Masimo Rainbow tester will not work with the Previous version Rad-57 monitor (see picture below and make note of the difference between the Previous orange encircled parameter button and the New gray encircled "Display" button.

Previous Rad-57

New Rad-57

Tester Specifications:

Parameter	Test Value
SpO_2	82% ± 3%
PR	61 ± 1
SpCO	7% ± 3%
SpMet	3.4% ± 1%
PI	~

2.11.2. Connect the Masimo Rainbow Tester to the Pulse CO-Oximeter.

2.11.3. Verify a reading appears within approximately 8 seconds. Verify the values are within the “Tester Specifications” table above.

2.11.3.1. If the unit has both SpMet and SpCO, the PI (Perfusion Index) indicator bar will not be available. The PI value will be displayed on the LED screen after pushing the DISPLAY button two times. There is no specification for the PI value.

2.11.4. Test the alarm limits at each of the following settings:

2.11.4.1. Initial parameter values are set to Factory Default :

SpO2: Hi OFF, LO 90%
BPM : HI 140, LO 50
SpCO: HI 10%, LO OFF
SpMet: HI 3%, LO OFF

2.11.4.2. Verify each **alarm-inducing** setting initiates an audible alarm and a visual alarm (Both levels of the LED display should flash). Verify the yellow “Alarm Silenced” LED is off during the alarm condition.

Test 1 (Non Alarming)

Limits	%SpO2
High	OFF
Low	90%

Test 2 (Alarming)

Limits	%SpO2
High	80%
Low	70%

Test 3 **(Non Alarming)**

Limits	BPM
High	140
Low	50

Test 4 **(Alarming)**

Limits	BPM
High	**60**
Low	55

Test 5 **(Non Alarming)**

Limits	% SpCO
High	10
Low	0

Test 4 **(Alarming)**

Limits	% SpCO
High	**6**
Low	0

Test 5 **(Non Alarming)**

Limits	% SpMet
High	4
Low	0

Test 5 **(Alarming)**

Limits	% SpMet
High	3
Low	0

2.11.5. Press the Alarm Silence button once and verify the alarm is silenced and the yellow “Alarm Silenced” LED is flashing.

2.11.6. Wait 120 seconds and verify that the alarm silence times out and the audible alarm is activated again and the yellow LED turns off.

2.11.7. To disable Alarm “Mute”, press the Alarm button once and verify an audible alarm is heard.

2.11.8. Press the up and down arrows while the unit is actively measuring vitals. Verify an increase and/or decrease in pulse volume. Continue pressing the down arrow to verify the pulse beep is silenced.

2.12. How to check software levels (Previous version Rad-57)

2.12.1. For ease of operation, remove the cable and/or sensor from the unit.

2.12.2. Verify the unit is turned off.

2.12.3. Press and hold the down arrow (▼) button while powering the unit on.

2.12.4. After a few seconds you should see a display in red that looks similar to “Ser”.

2.12.5. Press the NEXT button once to see the “Main” software level.

2.12.6. Press the NEXT button one more time to see the “MX-1” software level.

2.12.7. Pressing the NEXT button a third time displays a software version that is not needed in the troubleshooting of the Rad-57.

2.13. How to check software levels (New version Rad-57)

2.13.1. For ease of operation, remove the cable and/or sensor from the unit.

2.13.2. Power the unit on.

2.13.3. The unit should display “No CbL” prior to looking up the software versions.

2.13.4. Press and hold together first the up arrow (▲) button then the “Mode-Enter” button. This should be done in order and fairly quick.

2.13.5. After a few seconds you should see “Ser” on the display.

2.13.6. Press the “Mode-Enter” button once. You should now see UEr. The “U” actually is a representation of the letter “V” for Version.

2.13.7. Press the NEXT button once to see the “Main” software level.

2.13.8. Press the NEXT button one more time to see the “MX-1” software level.

2.13.9. Pressing the NEXT button a third time displays a software version that is not needed in the troubleshooting of the Rad-57.

2.14. Battery Test

2.14.1. Install four (4) “AA” alkaline batteries.

2.14.2. If the unit was installed with brand new batteries, all four (4) battery charge LED indicators should be illuminated indicating a full charge.

2.14.3. If all four (4) LEDs are not lit, then remove all four (4) batteries and try another set.

2.14.4. If all four (4) indicators are still not lit, then contact Masimo Corporation for a return authorization.

3. Repair

3.1. Safety Precautions:

WARNING: DO NOT DISASSEMBLE OR ASSEMBLE THE UNIT WHILE THE BATTERIES ARE STILL INSTALLED.

WARNING: ENSURE THE UNIT HAS BEEN PROPERLY CLEANED PER THE CLEANING INSTRUCTIONS.

3.2. General Procedures

3.2.1. Examine for cosmetic damage prior to disassembly or troubleshooting. External damage may be helpful in determining the root cause of the failure.

3.2.2. Note any markings or labeling the end user may have placed on the unit that may need to be duplicated or transferred in the event the housing or ancillary components are to be replaced.

3.2.3. Make note of the unit serial number.

3.2.4. Make note of the unit's software versions in the event the Pulse CO-Oximeter board or system board is replaced. These boards will require software versions compatible with the unit's latest configuration.

3.2.5. Contact Masimo Corporation to determine warranty status.

3.3. Troubleshooting

3.3.1. The troubleshooting procedure in this manual instructs the technician to isolate the failure down to the sub-assembly level. The intention is to have the Unit Under Test (UUT) repaired with minimal steps. The Masimo Rainbow Tester is needed to perform the Performance Verification in Section 2.10 upon completion of repairs.

3.3.2. Tools required are as follows:

Phillips head screwdriver #0
Multimeter

3.3.3. The troubleshooting steps below are presented in order of the most probable cause first. Proceed to the next step only if the unit continues to fail.

3.3.4. Always note the software versions of boards prior to repair.

3.4. Service Messages:

Upon detection of a system error, the main software alerts the user with an audible alarm indicator and displays the appropriate error code on the Handheld's main display. The MX-1 board is held in reset and no other runtime functions are available to the user until the Handheld is put through a power cycle or until batteries are removed and (removal and replacement of batteries).

System Error	System Error Code
MX-1 Board Failure	1
MX-1 Board Communication Failure	2
5V Voltage Supply Out of Range	3
Red Voltage Supply Out of Range	4
Blue Voltage Supply Out of Range	5
Battery Drop Voltage Out of Range	6
Battery Voltage Out of Range	7

Symptom	Cause and Corrective Action Steps
• **Speaker Alarming (loud, continuous tone) and unit is not functioning.**	• **Probable Watchdog error.** 1. Replace System Board.
• **Alarm LED does not Illuminate** 1. Unit is in an alarm state and an audible alarm can be heard.	1. Replace Keypad. 2. Replace System Board.
• **Alarm Condition but No Audible Indication.** 1. Unit is in an alarm state.	1. Replace Speaker. 2. Replace System Board.
• **Alarm Silence LED not illuminated.** 1. Unit is in a non-monitoring state. No alarm indicated.	1. Replace Keypad. 2. Replace System Board.
• **Display Missing Segments**	1. Replace System Board.
• **Button Function Error** 1. Pressing one or more buttons will not activate the menu selection.	1. Replace Keypad. 2. Replace System Board.
• **Batteries do not last very long with unit turned off. (less than 1 or 2 days)**	1. Verify use of only AA Alkaline batteries. **(DO NOT USE RECHARGABLE BATTERIES).** 2. Verify Trend function is set to OFF. (Leaving Trend function ON will cause the batteries to drain even though the unit is turned off)
• **"No Sen" Message** 1. Cable is connected with sensor attached.	1. Replace sensor. 2. Replace patient cable. 3. Replace Pulse CO-Oximeter board.
• **"No CbL" Message (Rad-57)** 1. Cable is connected.	1. Replace patient cable. 2. Replace Pulse CO-Oximeter board.
• **SpCO or SpMet scale LEDs not illuminated** 1. Rainbow cable (w/sensor attached) or direct-connect Rainbow sensor is plugged in.	1. Replace cable or sensor. 2. Replace Keypad. 3. Replace system board. 3. Replace Pulse CO-Oximeter board.
• **SpO2 reading OK, but not acquiring SpCO or SpMet reading.**	1. Verify a “Rainbow” sensor or cable is being used. “Red” sensors or cables will only provide SpO2 readings. 2. Replace Pulse CO-Oximeter board.
• **Unit Will Not Turn Off**	1. Replace Keypad. 2. Replace System Board.

If unable to repair unit, then please call (800)326-4890 option #2 to arrange for return to Masimo Corporation.

4. Repair and Returns

4.1. Repair Policy

4.1.1. Masimo or an authorized Service Department must perform warranty repair and service. Do not use malfunctioning equipment. The product must be repaired.

4.1.2. Please clean contaminated/dirty equipment before returning. Make sure it is fully dry before packing the equipment.

4.1.3. To return the Rad-57 unit for service, please follow the Return Procedure outlined in this section.

4.2. Return Procedure

4.2.1. Please clean contaminated/dirty equipment before returning and make sure it is completely dry before packing the equipment.

4.2.2. Recommended decontamination procedure for Rad-57 units that had the potential for being exposed to infectious materials.

4.2.2.1. Put on Lab coat or other protective garment.

4.2.2.2. Put on gloves.

4.2.2.3. Place equipment on the designated decontamination table.

4.2.2.4. Apply cleaning agent (preferably 10% Bleach to Water solution) to paper towel or use Cidex wipes.

4.2.2.5. Wipe down all aspects of the equipment.

4.2.2.6. Let the equipment air dry completely.

4.2.2.7. Remove gloves.

4.2.2.8. Move equipment to the area designated for equipment that has been through the decontamination process.

4.2.2.9. Dispose of all contaminated products properly.

4.2.3. Package the equipment securely – in the original shipping container if possible – and enclose the following information and items:

4.2.3.1. A letter or email describing in detail any symptoms or difficulties experienced with the pulse oximeter. Please include the RMA number in the letter.

4.2.3.2. Warranty information – a copy of the invoice or other applicable documentation must be included.

4.2.3.3. Purchase order number to cover repair if the oximeter is not under warranty, or for tracking purposes if the warranty is in effect.

4.2.3.4. Ship-to and Bill-to information.

4.2.3.5. Person (name, telephone/Telex/fax number, email and country) to contact for any questions about the repairs.

4.2.3.6. A document stating the Pulse CO-Oximeter has been decontaminated for blood borne pathogens.

4.2.4. Contact Masimo Technical Support for a return authorization.

4.2.5. Return the Pulse CO-Oximeter to the following shipping address:

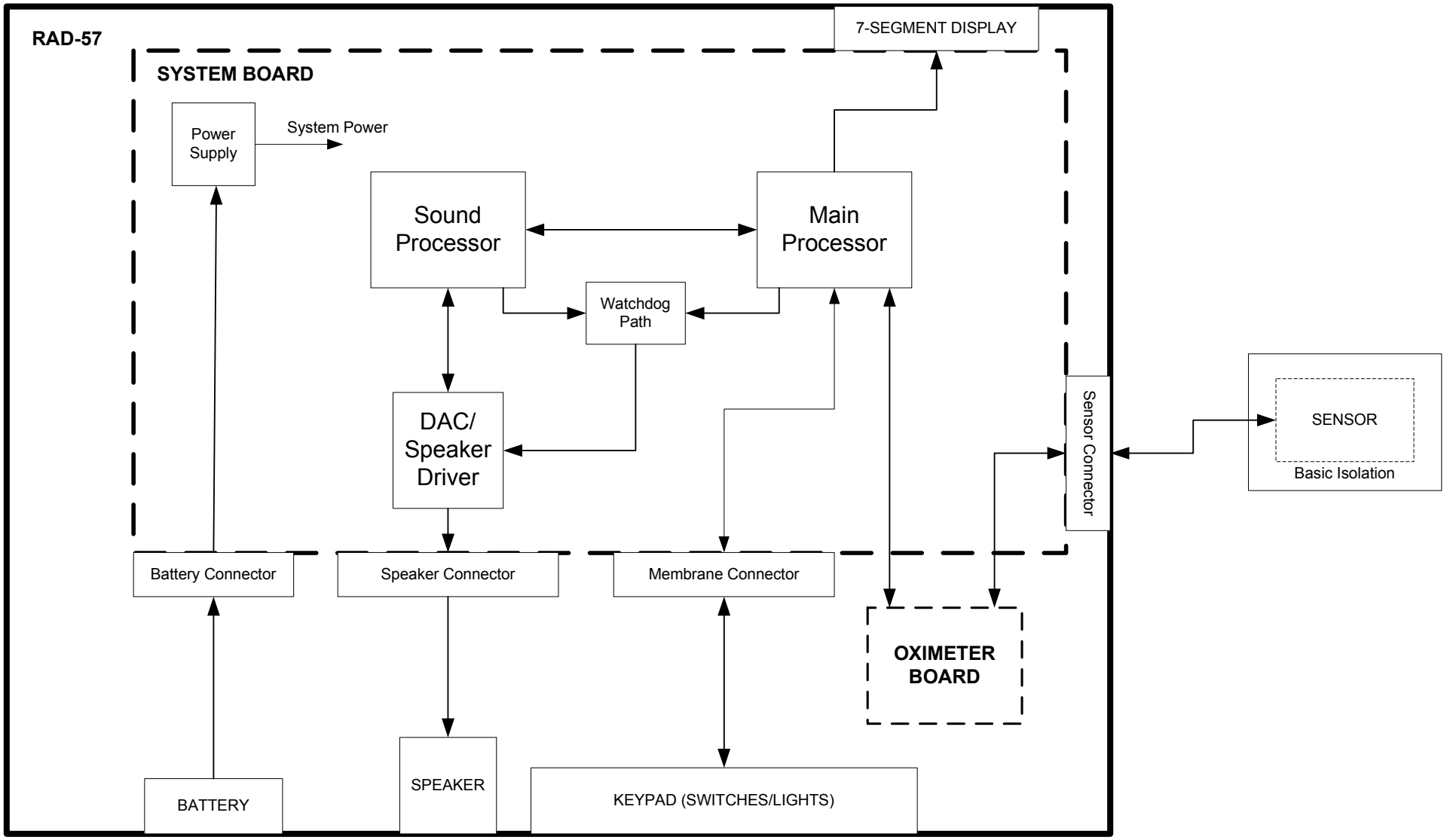
Masimo Technical Support
40 Parker
Irvine, California
USA 92618

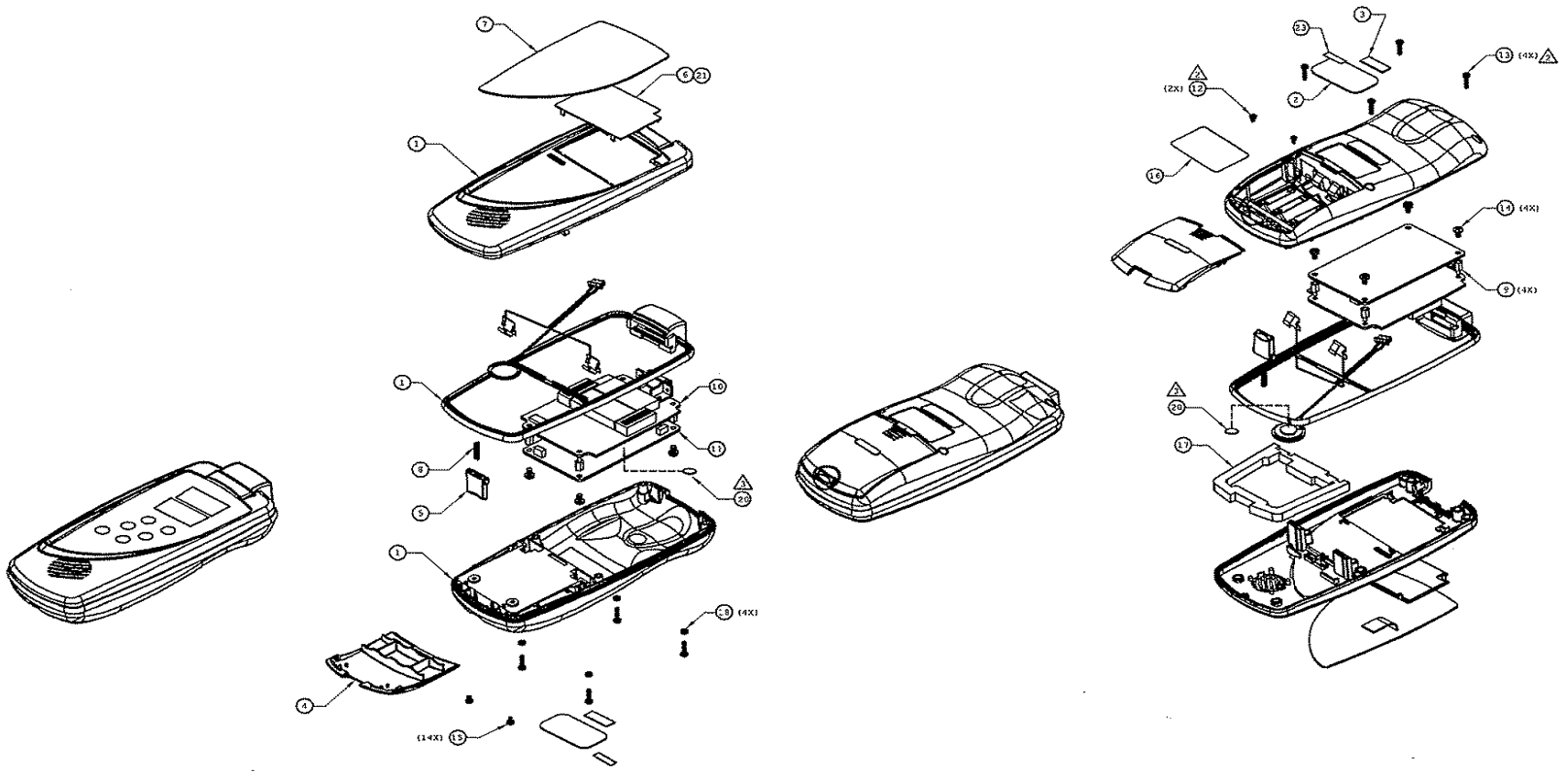
(Domestic Toll Free): 800-326-4890, option #2
(International): 949-297-7498, option #2
FAX: 949-297-7499 (Attn: Masimo Technical Support):

15823 / 5860A-0709

5. Drawings and Schematics

RAD-57 SYSTEM BLOCK DIAGRAM





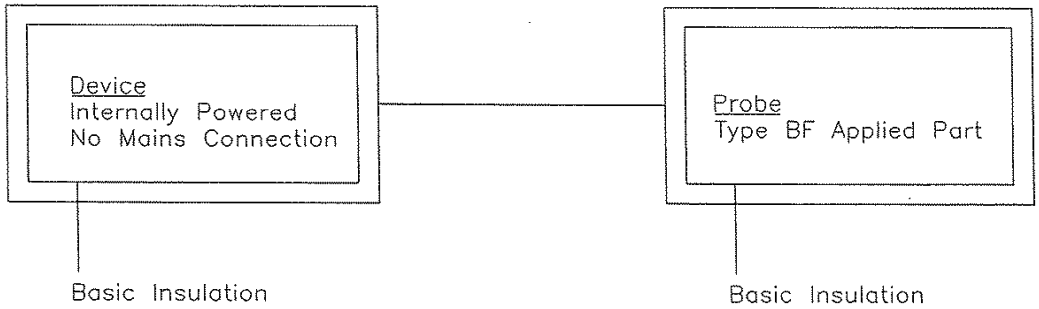
NOTES:

1. ⬭ INDICATES MASIMO INSPECTION DIMENSION PER AP-10020.
2. APPLY ADHESIVE (15) TO SCREWS PRIOR TO SECURING THE SCREWS.
3. PLACE/APPLY ITEMS 20 & 21 AS INDICATED IN PRODUCT ASSEMBLY PROCEDURE.

TOLERANCES (EXCEPT AS NOTED) .X = ±.1 .XX = ±.01 .XXX = ±.005 ANG = ±1°	DR/REV: D. NELSON	03/21/05	MASIMO
	CHK:		PART IS LISTED IN UL FILE: NO
	APP:		
	MFG:		TITLE: ASSEMBLY, RAINBOW HANDHELD INSTRUMENT I, SpCO
DO NOT SCALE DWG	QA:		SIZE: C DWG: R-DR-21417 REVISION: E
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED	THIRD ANGLE PROJECTION		SCALE: NONE SHEET: 1 OF 3

Rad-57 Bill of Material

Dwg Item	Required	Description
1	1	KIT, PLASTIC WITH SPEAKER, RAD-57
2	1	LABEL, RAD-57, CERTIFICATION, UL, MASIMO
3	1	LABEL, RAD-57, SERIAL NUMBER, HAND 4-UP (Not available for sale)
4	1	COVER, BATTERY, HANDHELD P.O. (WHITE)
5	1	BUTTON, CATCH, HANDHELD P.O. (WHITE)
6	1	WINDOW, HANDHELD ENCLOSURE
7	1	KEYPAD, RAINBOW, SpCO/SpMET RAD 57cm
8	1	SPRING, COMPRESSION, HANDHELD BUTTON
9	4	STANDOFF,3/16" HEX 1/4",2-56 MALE,10/PK
10	1	RHI-1 SystemBoard, Prog, SpCO/SpMet
11	1	MX-1 Board, V7.4.0.9,SpO2, PR and PI Par
12	2	SCREW, FLAT HEAD, #2-56 X 3/16", 25/PK
13	4	SCREW, PAN HEAD, #2-56x7/16", 100/PK
14	4	SCREW, #4-40, 3/16" PHILLIPS, PH, 100/PK
15	0.0005	ADHESIVE,CYANOACRYLATE,LOCTITE 262
16	1	LABEL, BATTERY COMPARTMENT, RAD-5/RAD-57
17	1	GASKET, BATTRY COMPART ENSOLITE IV1 RoHS
18	4	GASKET, SCREW HOLE PORON .062"thk RoHS
19	1	CARBOXYHEMOGLOBIN SATURATION (SpCO)
20	3	ADHESIVE BACKED POLYURETHANE BUMPER DOME
21	0.0005	UV ADHESIVE DYMAX 204 CTH
22	1	METHEMOGLOBIN SATURATION (SpMet)
23	1	LABEL, ASSEMBLED IN MEXICO



NOTES:

1. Basic Insulation =
   1.5kVAC HI POT
   4mm Creepage Distance
   2.5mm Air Clearance
2. Classification: Internally Powered Equipment
   Operation: Continuous Operation
   Applied Part: Type BF

TOLERANCES (EXCEPT AS NOTED) .X = ±.1 .XX = ±.01 .XXX = ±.005 ANG = ±1°	DR/REV: J. SCHMIDT	8/22/05	MASIMO	PART IS LISTED IN UL FILE: NO
	CHK:			
	ENG:			
	MFG:			
DO NOT SCALE DWG	QA:		TITLE: RHI-1 ISOLATION BLOCK DIAGRAM	
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED	THIRD ANGLE PROJECTION		SIZE: A / DOC NO: R-DR-60019 / REVISION: A	
			SCALE: NONE / SHEET: 1 OF 1	

FRM1222 REV E; DRO-11990